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November 1981

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Outlook '82

The economic forecast for the global agricultural system and the prospects for food and fiber production in the coming year generate as much interest today as they did at USDA's first Agricultural Outlook Conference 58 years ago.

This major USDA information-sharing event now attracts a diverse international audience that has grown to more than 1,100 participants.

People from virtually every sector of the food and fiber system—producers, processors, planners, traders, and consumers—come together at Outlook to discuss all aspects of world and U.S. agriculture.

The broad participation is one dramatic difference from the early years of the conference. In 1923, at the first Outlook Conference, attendance was by invitation only and the meeting was held behind locked doors. In this secretive atmosphere the participants reviewed USDA's first report on farmers' planting intentions. The group was asked to determine whether the acreages that farmers had reported were in line with prospective demand. The secrecy was to prevent the information from affecting commodity markets.

The doors are open now, the conferences have become more varied, and the depth of coverage has increased.

Even with changes to reflect current concerns and issues, the function of the conference has remained basically the same—to serve as a forum for discussion and debate on food and agriculture prospects for the coming year.

For many years, ARS has joined in this effort to provide information on U.S. and world agriculture, food and fiber markets, and the use of food and farm products in industry and the home. This year, for example, ARS's Family Economics Research Group again played an active role in coordinating the sessions on "Home Economics: Outlook for Families."

The group worked closely with Extension Service, Economic Research Service, and others from organizations and universities around the country to provide the best expertise possible to discuss developments in this area.

This year, conference participants also focused on agricultural research and technology and its impact on production as we move into the 80's. Agricultural research has been a continuing interest over the years at the Outlook Conferences—frequently lending support to the economic and production outlook discussions.

The future of agricultural research today seems particularly challenging—just as it must have in 1923 when the conferences began.

Back then, a new age of technology had reached American farms. The lightweight gasoline tractor was just coming into its own. The breakthrough on hybrid corn had been accomplished and would be put to use in the 30's.

All through those years the seeds of the coming revolution in production continued to be sown by agricultural researchers—even as the country suffered through the Great Depression and farmers endured the tragedies of the Dust Bowl.

In the 40's, America's farms set food production records that sustained us through World War II. Then followed the real lift-off powered by science: the age of antibiotics, new pesticides, improved fertilizers, vertical integration, controlled livestock environments, mechanized farming, and cheap energy. Record yields followed one another, carrying us through the 50's and into the 60's.

Despite the outstanding accomplishments during those years of abundance, scientists were sounding warnings about resistance to insecticides, the loss of valuable germplasm, the pollution of water.

Now agricultural research faces challenges as tough as any in the nearly six decades since the annual Outlook Conferences began.

Agricultural research is being called on for solutions to problems in almost every area covered during this year's Conference—agricultural production . . . farm income . . . land and water issues . . . human nutrition . . . community and rural development . . . energy . . . transportation . . . home economics.

Work is underway to achieve the necessary advances in the sciences that support agriculture, and for the ensuing technology that will be needed under the different and difficult conditions that lie ahead. The results of ongoing efforts will surely affect the outlook picture and may be discussion topics at future USDA Agricultural Outlook Conferences.

By Maureen Quinn, S&E

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Agricultural Research
Vol. 30 No. 5
November 1981

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Agricultural Research is published monthly by the Agricultural Research Service (ARS), U.S. Department of Agriculture, Washington, D.C. 20250. The Secretary of Agriculture has determined that the publication of this periodical is necessary in the transaction of the public business required by law of this Department. Use of funds for printing this periodical has been approved by the Director of the Office of Management and Budget through June 15, 1982. Yearly subscription rate is $14 in the United States and its territories, $17.50 elsewhere. Single copies are $1.75 domestic, $2.20 foreign. Send subscription orders to Superintendent of Documents, Government Printing Office, Washington, D.C. 20402. Information in this magazine is public property and may be reprinted without permission. Prints of photos are available to mass media; please order by photo number.

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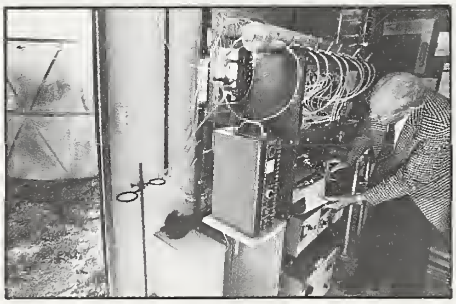
Cover: Open-Topped test chambers at Beltsville, Md., where field crops are exposed to controlled doses of air pollutants. ARS researchers are studying cumulative damage to crops caused by mixed pollutants. Story begins on page 4. (0981W1251-18A)

245 Air Pollutant Mixtures Damage Crops

Data on atmospheric conditions outside the test chambers are monitored here by plant pathologist Howard Heggestad (right) and plant physiologist Jesse Bennett. (1080A1228-7)



From an instrument trailer, Heggestad adds specific concentrations of sulfur dioxide to the test chambers. (1080A1228-17)

When the Pollutant Standards Index reaches 100, the air is considered "unhealthful," and people with respiratory problems are advised to stay indoors. But crops don't have that option. For sensitive plants, the result can be lower yields and damaged parts.

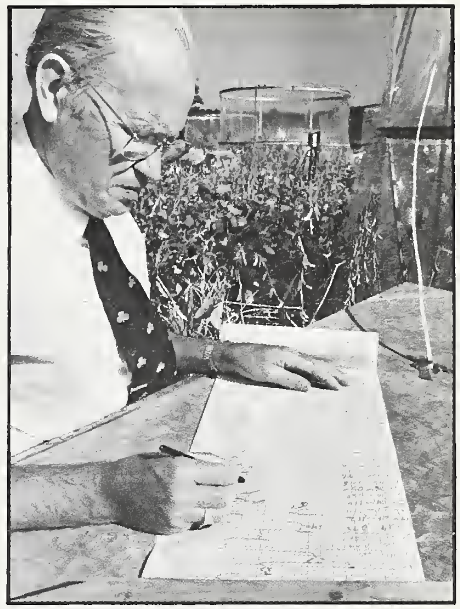
While the Pollutant Standards Index, better known as the air quality index, generally tops 100 because of high ozone levels, several other pollutants also control the index—sulfur dioxide, nitrogen dioxide, carbon monoxide, and total suspended particulates. At least one of these is adding to the "unhealthful" environment for crops, scientists at the Beltsville Agricultural Research Center are discovering.

"We know that present levels of ozone reduce yields of certain crops. Now, preliminary results show that mixtures of pollutants can cause even greater losses. And mixed pollutants are a common phenomenon," says Howard E. Heggestad, ARS plant pathologist, Plant Physiology Institute, Beltsville, Md.

In 2 years of tests, Heggestad and plant physiologist Jesse H. Bennett subjected the two most popular vegetables, snap beans and tomatoes, to a mixture of the most common air pollutants—ozone and sulfur dioxide. When sulfur dioxide was added to the ambient air, which already contained ozone, vegetable yields decreased as the sulfur dioxide concentration increased. In fact, the effects of the two pollutants were at least cumulative.

In earlier studies, Heggestad and colleagues evaluated the effect of ambient air on tomatoes, snap beans, sweet corn, soybeans, and potatoes. Ozone alone lowered yields of the 5 plant species an average of 10 percent. Heggestad points out that temperature, soil moisture, and humidity also play an important role in how pollutants affect plants because growth habits differ in different climates. Damage may not be so great in climates drier than the humid East Coast.

All studies showed that certain cultivated varieties of plants (cultivars) perform significantly better than others when pollution levels are low. But the latest study clearly indicated that the amount of leaf damage due to ozone is



Heggestad checks a chart recording the various levels of ozone and sulfur dioxide added to test chambers planted with soybeans. (0981W1253-19)

A soybean leaf exposed to ozone and sulfur dioxide is compared to a healthier leaf (left) that grew in carbon-filtered air. (0981W1253-9)

not a reliable indicator of a cultivar's potential yield in an environment of mixed pollutants.

Atmospheric sulfur dioxide levels in the United States have been markedly reduced over the past 15 years because of restrictions on sulfur content in fuels and industrial control devices such as scrubbers and taller smoke stacks. But because of the rising costs of oil and natural gas, sulfur dioxide levels are expected to increase as power-generating and industrial plants turn to coal, Heggestad points out.

According to a recent Environmental Protection Agency report, only 1 percent of the 385 stations currently monitoring sulfur dioxide report yearly averages above 0.03 parts per million (ppm), contrasted to 16 percent in 1970; most of these sites are located near plants that emit sulfur dioxide. However, yearly averages don't paint a complete picture. Readings of sulfur dioxide can go up and down like a seesaw on a daily basis, even from minute to minute, says Heggestad. About 13 percent of the monitoring stations in 17 states throughout the country report the highest 24-hour average concentrations to be greater than 0.11 ppm. That is approaching EPA's primary standard for sulfur dioxide of 0.14 ppm, a level which is not to be exceeded more than once a year. When this primary standard is reached or exceeded, the air quality index tops 100 for sulfur dioxide and the air is designated "unhealthful."

Metal smelters, by far, add the largest doses of sulfur dioxide to the surrounding air, often delivering 2-1/2 to 8 times the primary standard—levels that range from "very unhealthful" to well above "hazardous" on the Pollutant Standards Index. Urban industrial areas also have elevated sulfur dioxide levels, but their averages generally stay below the primary standard, set by EPA as the limit tolerable for public health.

Sulfur dioxide, which ranks second to ozone as a plant-damaging pollutant in the United States, is considered a point-source pollutant. "All of the sulfur dioxide concentrations we tested can be found downwind of some large smelters and coal-fired generators, but concen-

trations above 0.12 ppm are more short lived and infrequent in the real world than as used in our study," Heggestad explained.

On the other hand, ozone pollution, which is largely due to automobile exhausts, is everywhere. The primary standard for ozone is 0.12 ppm for 1 hour each year—a standard that is frequently exceeded in smoggy metropolitan areas. Over three-fourths of the ozone-monitoring sites in metropolitan areas around the country report daytime averages of 0.05 to 0.08 ppm. The averages during the Beltsville experiments were about the same.

In their tests, Heggestad and Bennett used open-top chambers to provide growing conditions as normal as possible for the test vegetables—a popular garden tomato and three common snap bean cultivars, which ranged from ozone-sensitive to ozone-tolerant for leaf injury. During the growing season, artificial atmospheres were pumped into the lower half of the chambers and escaped through the top, keeping the surrounding air out during fumigation. Plants were fumigated on weekdays during the late morning and early afternoon when ozone levels are usually highest.

The scientists used ambient air or various artificial atmospheres—carbon-filtered air (the filter removes most of the ozone), carbon-filtered air with sulfur dioxide, and ambient air with sulfur dioxide—to get a clear picture of the effects of each pollutant alone and in combination. In the chambers receiving mixed gases, they used three concentrations of sulfur dioxide—slightly less than half the primary standard (0.06 ppm), slightly less than the primary standard (0.12 ppm), and about twice the primary standard (0.24 ppm for tomatoes; 0.30 ppm for beans). During the second year of tests on tomatoes, they added a concentration more than three times the primary standard (0.48 ppm), but yields were not significantly different from those at the next lower concentration.

Although yields went down, tomatoes exposed to the pollutants suffered no measurable changes in quality. Here plant physiologist Edward Lee scores fruit color. (1080A1228-36A)

Snap beans were most seriously affected by the mixed pollutants, although the cultivars differed in their responses. When combined, the two pollutants caused more loss than the cumulative effect of each separately. This is known as synergism. Ambient air had no measurable effect on snap bean yields, and the highest dose of sulfur dioxide in carbon-filtered air reduced the bean crop 16 percent. However, a mixture of the two pollutants reduced yield 44 percent. Bean yields increased proportionally as the sulfur dioxide concentration decreased, but were still about 8 percent below yields from the control plots at the lowest sulfur dioxide concentration used. This led Heggestad and Bennett to conclude that even lower sulfur dioxide concentrations would also reduce productivity. This summer the scientists added a lower concentration (0.03 ppm) in an attempt to find the level where yield loss begins.

Synergism did not occur in the tomato studies. Tomato yields dropped as if the effects of the pollutants had been added together. Reductions ranged from 6 percent at the lowest sulfur dioxide concentration in ambient air to 20 percent at the highest concentration.

Sulfur dioxide did not change the taste or nutrient value of tomatoes. During the second year of sulfur dioxide studies, Edward H. Lee, ARS plant physiologist, and Bennett analyzed selections from the crop and found no change in color, total acidity, pH, or ascorbic acid content. When tomatoes were served to a taste panel, panelists found no difference in taste or texture.

Along with the tomato analyses, Lee also analyzed the top 3 inches of soil within the growth chambers to see if the gaseous sulfur dioxide had altered soil acidity. Extensive research has been done worldwide on the effects of acid rain resulting from sulfur dioxide and nitrogen dioxide pollution. Sulfur dioxide dissolved in rainwater can acidify the soil which, in turn, releases metals such as aluminum, iron, and manganese that can be toxic to plants.

After 13 weeks of fumigation, the lowest sulfur dioxide doses had not significantly changed soil acidity. Doses above 0.12 ppm increased soil acidity significantly. "Our results suggest that absorption of sulfur dioxide over many years could cause a problem, especially if the soil pH dropped below 4.5. However, farmers routinely lime their soils to keep the pH in the optimum range," he explained. Without liming, even low sulfur dioxide levels have the potential to acidify some soils to the dangerous point if given enough time, says Lee. Susceptible soils are low in clay and organic matter.

Heggestad and Bennett are now studying the effects of sulfur dioxide pollution on soybeans. Lee is running another series of soil analyses in a deeper soil layer—3 to 6 inches, the zone that generally contains most crop roots.

Howard E. Heggestad, Jesse H. Bennett, and Edward H. Lee are located at the Plant Stress Laboratory, Room 206, Bldg. 001, Beltsville Agricultural Research Center-West, Beltsville, MD 20705.—(By Judy McBride, Beltsville, Md.)

Volunteer Corn Control

Sprouting through a soybean canopy, "volunteer corn"—a common problem in corn-soybean rotations—stunts soybeans' growth and hinders harvest. (0881X985-27)

Heavy populations of volunteer corn reduced soybean yields by as much as 83 percent, but were controlled by herbicides in tests reported by Robert N. Andersen, ARS weed scientist.

Andersen, working with University of Minnesota researchers J. Harlan Ford and William E. Lueschen, planted corn in clumps of 10 kernels each at three spacing rates: 2, 4, and 8 feet apart in Hodgson soybeans planted in 30- or 40-inch rows.

"We used clumps because they are more typical of naturally occuring volunteer corn populations. Our infestation levels were high, but such levels can occur in patches in farm fields," Andersen says.

The 2-foot corn spacings cut yields 83 percent; the 4-foot spacings, 58 percent; and the 8-foot spacings, 31 percent. These are averages of 2-year tests at University of Minnesota experimental plots at Rosemont, Waseca, and Lamberton. The average loss of soybeans per clump of volunteer corn on the plots with the lightest rate, 1 clump per 8 feet, was 0.32 pound.

"In other words, every 180 clumps of volunteer corn per acre will reduce the yield about 1 bushel," Andersen says.

This estimate would include only the direct reduction in seed production, he adds. There would be additional losses due to harvesting problems caused by the corn.

The researchers were also comparing the two herbicides currently available for volunteer corn control: diclofop (Hoelon) for early postemergence spray application, and glyphosate (Roundup) applied with selective applicators such as a rope-wick system, which permits herbicide contact only with corn that is taller than the soybeans.

Two applications of glyphosate were made in all but one test, and the plots were cultivated and hand-weeded to remove all weeds other than corn.

Andersen found that diclofop was more effective in increasing soybean yields than was glyphosate at the higher corn densities. This was probably because the diclofop spray application could be made an average of 19 days earlier than the rope-wick applied glyphosate, allowing the corn less time to compete with the beans, Andersen says. Rope-wick applications had to wait for the corn to grow above the soybeans.

Andersen suggests early overtop application of diclofop for heavy infestations of volunteer corn. For lighter infestations, it may be cheaper to use glyphosate applied with a selective applicator such as a rope-wick unit.

Robert N. Andersen is located at the Department of Agronomy, Weed Research Laboratory, University of Minnesota, St. Paul, MN 55108.—(By Ray Pierce, Peoria, Ill.)

Florida Mangos Spark World Production

(PN-6830)

Florida's mango industry, although small, is a mighty midget and still growing. Like the lime and avocado industries, it survives in the face of expanding urbanization. Unlike the lime and avocado industries, mango yields have increased.

The flesh of mangos is usually orange-yellow, the taste is mild to rich and sweet, and some varieties can be very juicy. One nonscientific mango lover has facetiously labeled it the "bathtub fruit" because he contends that's an appropriate place to enjoy this juicy tropical delicacy.

According to ARS horticulturist Robert J. Knight, Jr., approximately 1,729 acres in Florida produce an average of 7,150 tons of fruit a year, worth $2 to $3 million.

The mango industry in the United States is based on cultivars that originated in Florida from imported germplasm—hereditary material that provided characteristics for the next generations.

"The two most important cultivars, Tommy Atkins and Keitt, and seven other cultivars from our state, produce 50 and 45 percent, respectively, of the total quantity marketed yearly in Florida," says Knight.

In the last 10 years, the U.S. market for mango fruit has more than tripled, due partly to replacement of less dependable cultivars with Tommy Atkins and Keitt.

The mango is a fruit of major economic importance in the world, ranking in production volume only behind grapes, bananas and plantains, citrus fruits, and apples.

Florida has exerted an influence on the mango industry out of all proportion to its size, despite the limited volume of its production when viewed on a world scale. Between 1889 and 1914, more different mango cultivars were brought to Florida from India, Vietnam, the Philippines, and elsewhere than had ever been assembled before in one geographic location.

The mango's breeding system depends on outcrossing (mating of different strains), and therefore thousands of chance seedling trees of mixed descent originated in Florida. Among these seedling trees were a few that had the desirable characteristics of dependable productivity, disease resistance, attractive appearance, and high fruit quality. Haden was the first major success, but it has now been replaced in Florida by more productive cultivars.

For the past 3 years, imports from Mexico of Florida varieties Tommy Atkins, Kent, Keitt, and Haden—that early cultivar once popular in Florida and now widely distributed to many parts of the world—have supplied 60 percent of the U.S. market.

Mango cultivars developed in Florida are now also commercially important in Brazil, Israel, Hawaii, and numerous Central and South American countries.

Brazil, the world's second largest producer of mangos, after India, has disease and varietal problems, and production is not adequate to meet domestic needs and to supply expanding foreign markets. However, the problems are well recongized, and research efforts to surmount them are in progress, says Knight.

Florida varieties may supply Brazil's mangos with new vigor, and because of its location on the opposite side of the equator, Brazil's crop of fresh mango fruit matures at a time of year that allows it to complement rather than compete with U.S. production.

Robert J. Knight, Jr., is located at the Subtropical Horticultural Research Station, 13601 Old Cutler Road, Miami, FL 33158.—(By Peggy L. Goodin, New Orleans, La.)

Trout Manure as Fertilizer

The restaurant rainbow trout capital of the United States has a problem that an ARS researcher is looking to turn into an advantage. Fish manure is being tested as a fertilizer.

About 95 percent of all rainbow trout served in U.S. restaurants comes from trout farmers in south-central Idaho. Last year these farms produced over 26 million pounds of trout.

Trout are an excellent food source. Besides being nutritious, they are efficient, providing 1 pound of food for every 2 pounds of feed consumed, more efficient than chickens. Unfortunately, a third of their feed also comes out as waste. Idaho trout farms last year produced about 17 million pounds of fish manure.

Traditionally, fish manure has rarely if ever been used. After a period of accumulation, it has been swept from the bottoms of raceways and flushed downstream. However, the Environmental Protection Agency has ordered fisheries to discontinue this practice.

ARS soil scientist J. Hamilton Smith at the Snake River Conservation Research Center, Kimberly, Idaho, had been studying the use of sugarbeet and potato processing wastewater for irrigating cropland when he learned of the fisheries' problem. He decided to test trout waste as a source of fertilizer.

To obtain manure for his study, he had a commercial fishery pump the bottom of a raceway into a settling pond. The pond water was decanted and, after a drying out period, the manure was collected and then applied to a cornfield in sufficient quantities to provide fertilizer rates of 175, 450, and 700 pounds of nitrogen per acre.

After the first year of tests, Smith seems pleased. "The fish manure decomposed well and gave good yields," he says. In comparing fish manure to commercial fertilizers he estimates that it will take "roughly 2 to 3 pounds of fish manure nitrogen to equal the results of 1 pound of nitrogen in commercial fertilizers."

At an Idaho trout farm, a worker vacuums fish manure from a pond. The manure will be partially dried and applied to test plots. (0981X1086-19A)

Smith plans to continue his tests for at least 2 more years. He wants to learn how much useable nitrogen can be expected from fish manure, and how much manure will be needed in given situations for such crops as corn and sugarbeets to provide good fertilization.

"Potentially, Idaho trout farms produce enough fish manure to fertilize at least 1,000 acres of cropland," Smith says.

J. Hamilton Smith is located at the Snake River Conservation Research Center, Route 1, Box 186, Kimberly, ID 83341.—(By Lynn Yarris, Oakland, Calif.)

Standing between two test plots, soil scientist J. Hamilton Smith compares the unfertilized corn on the right to the taller, greener plants fertilized with trout manure on the left. (0981X1094-4)

214 # Plant Substances Reduce Cholesterol C3

Wisconsin State cooperating researcher Zafeer Din (left) and chemist Warren C. Burger examine test chickens to be used in the search for substances that lower cholesterol. (0681X773-3)

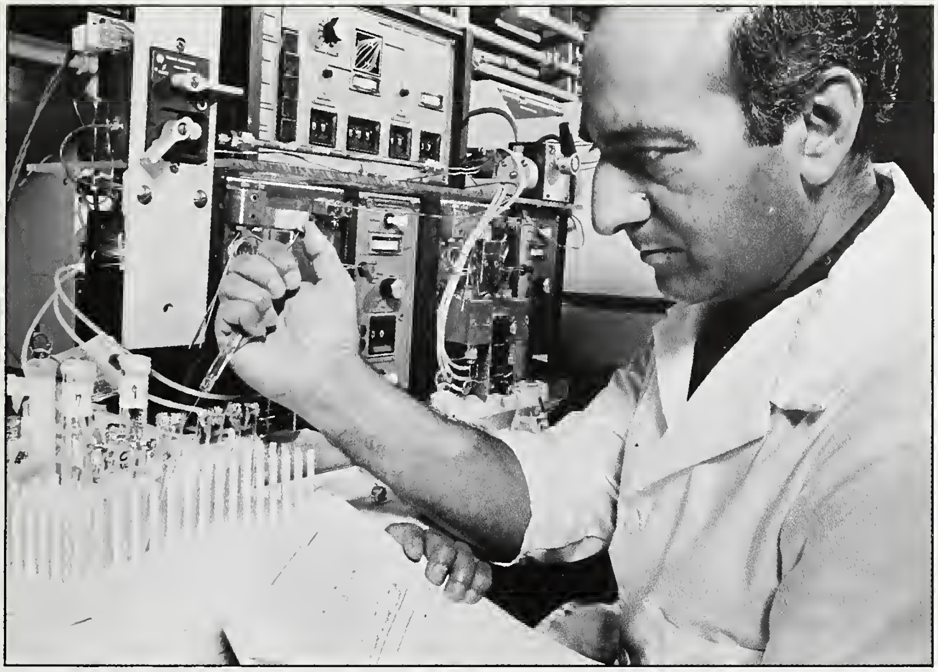
Both components of barley and a substance produced by a fungus, fed separately or together, lowered cholesterol concentration in blood plasma of chickens, pigs, and rats. In some cases these substances increased growth and feed efficiency.

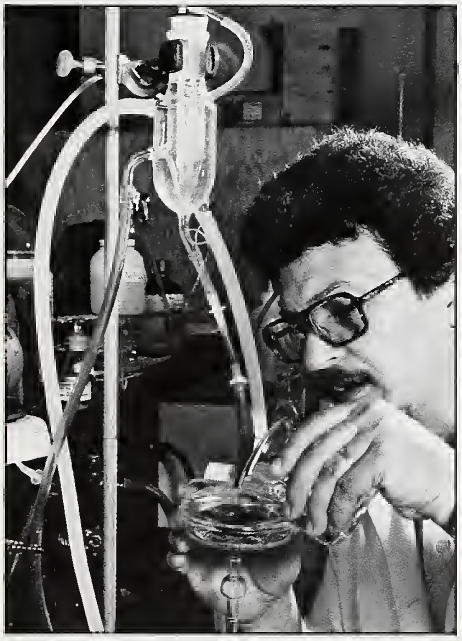
ARS and University of Wisconsin-Madison scientists are studying these phenomena because the discoveries may have favorable implications for both agriculture and human health.

"We added components from high-protein barley flour to a corn-based diet and increased chick growth by 20 percent and suppressed cholesterol concentration in blood plasma also by 20 percent," said chemist Warren C. Burger, research leader of the ARS Barley Quality Research Unit at Madison.

The scientists fed the components at a rate equal to a ration made up of 20 percent high-protein barley flour in a corn-based diet. Associated with Burger in the research are chemist Asaf A. Qureshi and nutritionist Charles E. Elson of the University of Wisconsin and ARS chemist Neville Prentice.

"High-protein barley flour, which constitutes 5 to 10 percent of intact barley, is not especially rich in fiber," says Burger. "Many studies in man and animals have pointed to consumption of dietary fiber as a way to influence cholesterol concentrations in the body, but the substances we're working with are not fibers."





Above:
High-performance liquid chromatography allows chemist Asaf Qureshi to separate and collect samples of active cholesterol-lowering substances from barley. (0681X773-11)

Left:
Biochemist Naji Abuirmeileh prepares a mixture of live cells from chicken livers. When purified barley components are added, the cells reveal the activity of cholesterol-inhibiting enzymes. (0681X773-17)

The researchers have not yet determined the chemical makeup of the cholesterol-lowering substances from either barley or the fungal product. They do know that more than one compound in barley is associated with the concurrent lowering of cholesterol and increased growth rate.

Burger said the fungal product that the research team fed the animals was a freeze-dried culture filtrate of the fungus *Trichoderma viride*. It produced effects characteristic of the female hormone estrogen, lowering cholesterol biosynthesis more in female chickens than in males.

Pullets on a diet supplemented with the culture filtrate began their egg laying 3 to 6 weeks earlier than their counterparts on a control diet of corn without the culture filtrate. Eggs from the birds on the supplemented diet were about 7 grams heavier than those from the control birds, and the yolks contained 20 percent less cholesterol.

From the age of 12 to 18 weeks the pullets consumed 50 milligrams of crude culture filtrate in each kilogram of feed. For an additional 12 weeks they consumed 100 milligrams for each kilogram of feed.

Longer term studies will help the scientists find whether the culture filtrate affects the fertility and hatchability of eggs.

The researchers first began feeding culture filtrate in studies aimed at determining what substances in barley prevent it from being a good feed for young chicks. They reasoned that an enzyme in *Trichoderma viride,* which digests plant gums (beta-glucan's), might alleviate digestive problems in chickens on a barley diet. When those studies are completed scientists will have a better idea than they now do as to whether barley should be bred for low beta-glucan content.

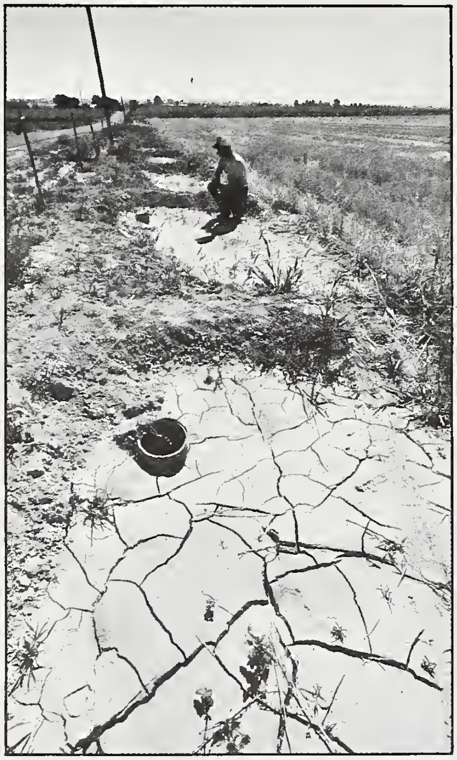
In their studies on barley and culture filtrate the scientists have shown that the diet affects activity of certain key enzymes in chicken, rat, and pig livers. These enzymes control the rate at which cholesterol is made and broken down into bile acids, says Burger.

Studies on pigs, which more closely approximate studies on humans than those on chickens or rats, showed that fatty tissue was the major site of cholesterol biosyntheses. Following in order of importance was tissue of intestine, liver, lung, and muscle.

Along with revealing new aspects of barley's nutritional quality, further research may give scientists insights on how enzymes work together to control cholesterol in animals on high cholesterol diets or why thyroid-deficient or diabetic animals are unable to degrade cholesterol efficiently. The studies are continuing under grants from the National Institute of Health's National Heart, Lung and Blood Institute, USDA's Competitive Research Grants Program, and Hatch funds administered through the University of Wisconsin-Madison.

Warren C. Burger is located at the Barley and Malt Laboratory, 501 North Walnut Street, Madison, WI 53705—(By Ben Hardin, Peoria, Ill.)

Buried Pipe System Controls Furrow Erosion



Upper left:
Furrow irrigation minus the tailwater ditch: Runoff from an irrigated field swirls through a riser into an underground pipeline. (0981X1095-24A)

Upper right:
About a week after an irrigation, research technician Robert Berg inspects the sediment ponds around risers at furrow ends. Eventually, sediment will fill the ponds, allowing expansion of the cultivated field. (0981X1096-11A)

Below right:
Berg holds plastic drainage tubing. Risers fastened to T-sections conduct runoff from the furrow ends into the underground pipeline. (0981X1097-30)

What is being called a "buried pipe runoff control system" promises to control furrow erosion and expand the productive areas of fields by 3 to 10 percent with rich sediment.

Conceived by ARS soil scientist David L. Carter at the Snake River Conservation Research Center, Kimberly, Idaho, the new system combines buried pipe drains with small sediment basins to eliminate tailwater furrow ditches. Eliminating tailwater ditches not only expands the useable area of a grower's field, it also cuts down on weeds and allows easier operation of farm equipment on the field.

A furrow is both a conveyance system and an infiltration system. As irrigation water flows down through a furrow, stream size decreases because of infiltration. To stretch the entire length of a furrow, an excess of water must be applied. It is estimated that 20 to 60 percent of the water applied to furrows becomes surface runoff.

To catch this excess water, growers commonly dig a ditch along the tail end of their furrows. A tailwater ditch is generally 6 or more inches deeper than the furrows and sloped steeply enough so that runoff flows rapidly from the field.

The problem is that as water falls from the furrow into the ditch, it carries with it soil from the furrow. Though undramatic at any given time, this erosion recurs with each irrigation, year after year. Gradually the lower end of the field becomes convex-shaped with an ever-increasing slope. It's not unusual to find fields with furrows eroded as much as 65 feet from the tail ditch.

Carter's solution is to bury a pipe in place of the tailwater ditch and to cover it over until only a column of risers—spaced 20 to 60 feet apart, according to need—protrudes above the soil surface. Initially, dirt dikes are erected on the downslope side of the risers to back the water up to a depth that it runs down the risers into the pipe. This forms small sediment ponds. After a few irrigations, the ponds are filled with sediment to the top of the risers and the convex end of the field is leveled. Once a field is leveled off, excess irrigation water runs down into the risers without accumulating at the tail end of the field.

Burying the pipe allows equipment to pass over it. Risers may be struck by tractors with no damage because both risers and pipe are made of a flexible polyethylene material, thin but tough. This material is much more durable and less expensive to install than metal or concrete.

"At 17 sites in various tailwater ditches last year, we managed to capture between 5 and 12 tons of sediment per acre," says Carter.

David L. Carter is located at the Snake River Conservation Research Center, Route 1, Box 186, Kimberly, ID 83341.—(By Lynn Yarris, Oakland, Calif.)

Straw Reduces Furrow Erosion

Straw in irrigation furrows filters sediment out of the runoff water, cutting erosion from furrow-irrigated fields. (PN-6835)

So long as a small amount of plant residue is retained in an irrigation furrow, tillage needed for herbicide applications and seedbed preparations can be conducted with little if any erosion.

ARS soil scientists John S. Aarstad and David E. Miller, Prosser, Wash., found that when straw, adding up to slightly less than a ton per acre, was uniformly placed in furrows, runoff water was cleaner—more free of soil particles—than the water originally entering the furrows.

"If such small amounts of straw are so effective in reducing furrow erosion, it should be possible to perform limited tillage and still leave sufficient residue in the furrows for erosion control," says Aarstad.

Soil erosion remains one of agriculture's worst problems. Dryland erosion has received a lot of publicity lately, but erosion in irrigation furrows can be even worse. Losing 4 to 14 tons of soil per acre from furrows during each irrigation is common.

No-till or reduced tillage is generally accepted as an excellent way to control this great soil loss. However, a major complaint against this technique has been that some tillage is needed for operations such as herbicide applications and seedbed preparations—more than no-till or reduced tillage customarily call for.

The ability of plant residues to reduce erosion from precipitation runoff has been known for many years, but because furrow irrigation has until recently been practiced on clean-tilled soil, residue effectiveness in controlling furrow erosion was paid little attention.

In 1978, Aarstad and Miller reported that corn residues in irrigation furrows all but eliminated soil erosion completely. They did not at the time determine how much residue was required to provide satisfactory control—information very much needed because tillage destroys residues.

Aarstad and Miller conducted their latest residue study on a medium-textured soil with a 3 percent slope. Even the lowest residue rates tested, a clump of straw every 6-1/2 feet down the furrow length, greatly reduced sediment in the runoff water, but the most effective treatments were 1/4 to 1 ton per acre applied uniformly along the furrow.

Chisel plows, disk plows, and disk tillers can all be used to till the soil without destroying much residue, but Aarstad says that techniques for the proper placement of residues in furrows will have to be developed.

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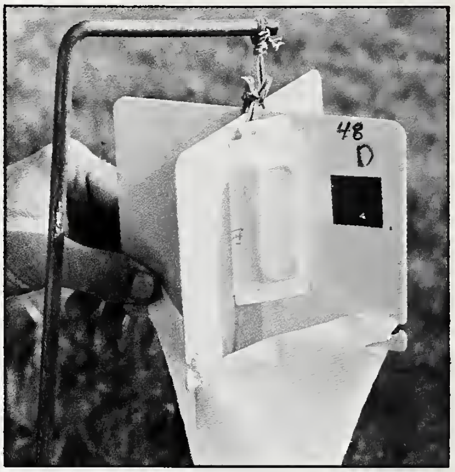
Japanese Beetle Lures

Research entomologist Michael Klein removes a bag full of Japanese beetles trapped during a test of various lures and commercial dispensers. Trapped beetles are counted daily. (0981X1070-21A)



The floral lure dispenser fits into the trap's "wing"; laminated material impregnated with the sex attractant appears as the dark patch. (0981X1070-23A)

Food and sex prove to be an irresistible combination of baits in Japanese beetle traps, increasing capture up to eightfold.

When the larvae change to beetle form and come out of the soil, they are ready and willing to fly several miles seeking food and sex. They will feed and breed for 30 to 60 days, which provides plenty of time to do serious damage.

Scientists have been fighting a chemical and biological war against Japanese beetles for years, and have been luring them into traps with food-type baits, improving the lures as they discovered more effective materials.

Now the researchers have added a sex attractant to the food lures. ARS research entomologist Michael G. Klein said that ARS researchers at Wooster, Ohio, and Gainesville, Fla., synthesized the attractant, based on the chemical released by female beetles. When added to food baits it increased captures in some test traps by as much as 800 percent during the height of the breeding season.

The trap was designed by USDA researchers back in the 1920's at Moorestown, N.J., and improved and patented in 1935. Commercial companies have been marketing modifications of this trap, along with food lures developed by USDA researchers, for several years.

The quest for lures began in 1919. One of the best basic lure materials currently in use is phenethyl propionate, called PEP. It was developed by ARS scientists at the Japanese Beetle Research Laboratory, Ohio Agricultural Research and Development Center, Wooster, in 1970, patented by USDA, and licensed by commercial companies. It is a synthetic material, similar to a chemical produced by grapes, and apparently appeals to Japanese beetles.

Next, the scientists found that the addition of eugenol, found in clove oil and used in perfumes and flavors, improved the drawing power of PEP. The lure was recently improved again by the addition of another natural material, geraniol, a product of roses, commonly used in soaps and perfumes. Beetles like it too.

So, to the combined drawing power of roses, cloves, and whatever it is the beetles think PEP smells like, the researchers now have added the female sex attractant, chemically known as (R,Z)-5-(1-decenyl)dihydro-2(3H)-furanone, called Japonilure for short.

The lure materials are attached to two metal or plastic plates fastened to each other at right angles with a funnel-shaped piece at the bottom. The beetles, not noted for their grace and agility, fly along following all the smells until they bang into one of the plates, fall down the funnel into a bucket or plastic bag, and are trapped. When the sun shines on the container, it heats up and the beetles normally die of heat stroke.

The synthetic sex attractant was produced and purified by ARS research chemists J. H. Tumlinson and Robert E. Doolittle at the Insect Attractants, Behavior and Basic Biology Laboratory, Gainesville, Fla. Synthesizing the lure was vital because there is no practical way to acquire the natural material. One female may produce only one billionth of an ounce during her lifetime.

The tests were run at Wooster by Klein and ARS research entomologist T. L. Ladd. They found that male beetles were attracted more strongly by the sex attractant early in the season and by the food attractants later in the season.

Adult Japanese beetles feed on leaf tissue between the veins, leaving a lacy skeleton. They often mass on ripening fruit, feeding until nothing edible is left. (0874X1457-3A)

Japanese beetle larvae: white grubs spend this life stage in the soil feeding on roots of plants, particularly grasses. The damage often goes unnoticed until the plants are permanently stunted or die. (0674R989-2)

"The combination of the two kinds of lures provides a much more effective attractant throughout the trapping season than does either the food or the sex attractant used separately," Klein said.

During the peak period of beetle emergence in Ohio tests, the combination of lures averaged 2,507 beetles per trap per day. Traps baited only with sex attractant averaged 1,186 beetles and those baited only with food attractants caught 652 beetles per trap.

Later in the season, the combination of attractants averaged 849 beetles per trap. The food attractants averaged 440 per trap and the sex attractant caught 89 beetles per trap, Klein reported.

The lure materials can be used in several ways. The sex attractant might be sprayed in an area during breeding season to confuse the males so badly that they cannot find females. A few traps can be used simply to survey an area to see if beetles are around and in what population concentrations. Traps are now used in California around airports to catch new arrivals before they can establish a population.

"Several companies have traps and lure materials on the market," Ladd said. "You can buy the attractant materials and make your own trap or buy complete units."

The beetles are working from Alabama north into Canada and westward to Tennessee, Missouri, and Illinois. They attack lawns, golf course turf, pastures, corn, tomatoes, strawberries, soybeans, grapes, roses, and many other desirable plants. They are not all that discriminating, however. They will wipe out an occasional smartweed and even molest poison ivy now and again, Ladd said.

The Japanese beetle season, of course, varies with the climate for a specific area. The grubs change into beetles and begin to emerge from the soil about mid to late May in the South. In the central part of the country they show up somewhat later, and in the northern states and Canada the beetles emerge during early to mid-July, Ladd said.

The Japanese beetle was first discovered in this country in Riverton, N.J., in 1916, feeding on ornamental plants in a nursery. The beachhead force probably arrived from Japan in a shipment of iris. The beetle now has an occupational force covering more than 300,000 square miles and is still spreading, attacking the more than 300 plants it enjoys.

Eggs hatch from midsummer to early fall and the grubs move down into the soil when cold weather comes. They begin feeding on roots again in the spring. Then they change to the beetle form and come to the surface to begin the cycle again.

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of Agriculture

G-95

Agrisearch Notes

Watering apples. Irrigation techniques can affect apple product quality. A recent ARS study has shown that Golden Delicious apples intended for fresh market and for applesauce are better grown under trickle irrigation than under sprinkler irrigation

Apples from trickle-irrigated plots were higher in yellow color and soluble solids and lower in acidity and moisture than apples from sprinkler-irrigated plots in tests conducted by ARS food technologist Stephen R. Drake, Prosser, Wash.

Trickle irrigation is being used more and more in major orchard areas all over the world because it saves water while maintaining soil moisture for fruit trees. Previous studies have indicated that apple trees under trickle irrigation respond differently than trees under sprinkler irrigation.

According to Drake, apples from trickle-irrigated plots at harvest are apparently more mature and ready for eating than sprinkler-irrigated apples. Applesauce from trickle-irrigated apples is superior in consistency and develops less weep (the water part of the sauce).

Because of the higher moisture content, apples grown with sprinkler irrigation are better for making apple juice and canned or frozen apple slices. Since the fruit is less mature at harvest, sprinkler irrigation is also better when the apples are to be stored for a prolonged period of time.

Most of the apples grown in the eastern United States are for processing, while over 80 percent of the apples grown in the Pacific Northwest are for the fresh market.

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Automated corn borer rearing system. Innovative equipment plus newly designed oviposition cages have minimized hand operations and enabled researchers to rear large numbers of the southwestern corn borer efficiently and effectively, to be used in corn breeding programs.

Since 1976, a major research effort has been underway to develop plant resistance to the southwestern corn borer, a serious pest of corn and an important obstacle to double cropping in the southern states.

The research effort of ARS's Corn Host Plant Resistance Research Team, Mississippi State, Miss., required that large numbers of the insect be reared artifically for testing the new corn material being developed. Before 1976, the southwestern corn borer rearing program was small and required hand labor for each operation.

Hand labor proved too costly and time consuming, so ARS entomologist Frank M. Davis and technician Thomas G. Oswalt began a step-by-step process to automate the entire rearing system.

First, Davis devised a portable precision diet dispenser that dispenses 1 gallon of diet every 5 to 7 minutes. Next, the scientist modified a food packaging machine for automatically infesting diet-filled cups with insect larvae mixed in corncob grits, and then capping each cup in a continuous operation at a rate of 65 cups per minute.

The scientist's third step in automation was to develop and construct a machine that removes the pupae from the cups at a rate of 20 cups per minute and collects these pupae.

The final step was to design and build a large oviposition cage (a chamber in which the insects could lay eggs) that is 10 times the size of the previously used cage yet requires no more time to service than the smaller cages.

The equipment is quite versatile and can be used to rear other insects as well. Davis points out, for example, that corn earworms and fall armyworms are presently being reared using the same diet and equipment. Only oviposition cage designs were changed because of the different behavior of the armyworms and corn earworms. Moreover, Davis says, "An automated rearing system has been developed that can be used for a number of other insect species. Indeed, the system is now being used in private industry and state university research."

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